Fertigation in blueberries in Concordia, Argentina

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Abstract

The experiment examined the effects of two drip irrigation systems with three levels of Calcium and Potassium, in O’Neal variety of blueberry (Vaccinium corymbosum L.). It was developed in the south of Concordia, Entre Ríos province, Argentina. Plants were implanted in October of 2004, at 3 meters between rows and 90 cm between plants, after one year in nursery, in a sandy soil. Fertigation treatments were: two irrigation lines per row with drippers each 30 cm, giving 0.8 of Eto, and three laterals with drippers each 30 cm per row, giving 1.2 of Eto. Each irrigation treatment was tested with three levels of Calcium and Potassium. Irrigations were done, when soil water potential reached 10 centibars, refilling the soil up to 5 cb, measured with gypsum blocks. Statistic design was complete randomized blocks of 5 plants per block, with 5 repetitions per treatment. The number of fruits varied from 342 to 466 between treatments. The weight of fruits, from 1.36 up to 1.73 gr per fruit. Treatments combining 1.2 of Etc, and maximum level of Ca and K that reached 3.160 kg ha⁻¹ were measured between October 7th and November 25th, 2006.

INTRODUCTION:

The trial area receives approximately 700 to 1450 mm of annual rainfall a year, irregularly distributed year long. The area presents sandy soils which are preferred to grow blueberries. This crop has a superficial root system. These three factors may result in periods of water deficit. There are several reports proving that trickle irrigation systems increase yields in different crops in humid regions (Pannunzio et al., 2000) (Pannunzio y Genoud, 2000).

Blueberry growth and yield correlate possitevily with irrigation and fertigation levels (Przybyla et al., 1999).

The water available in these sandy soils is around 10%. Acid organic matter, such as pine bark, pine dust, pine needles, are added to the soil in order to lower pH and reproduce similar conditions to those original ones. Organic matter is improving water storage capacity of the soils, melliorates environment so that biological process in the soil, can develop better. A dirt amount of trapezium shape of 100 cm of base, 60 cm on top and 40 cm height is made to set the plants on, easing the balance between air, solids and water in the soil and drainage of eventual excess of water.
Irrigation is a decisive factor due to the fact that blueberries have dense shallow root system (Gough, 1980; Freeman, 1983; Garren 1988; Eck, 1990). Water distribution is a key factor in production of blueberries (Garren, 1988).

Water potential in the soil has been proved to be of great importance to achieve high growing rates, being the advisable range between 10 and 20 centibars (Pritchard et al, 1993).

A deficit of water will be a depressive of growth as an excess of water (González, 1996).

The highest water demand happens right before harvesting with 19 liters per plant an day in drip irrigation irrigated crops (Jaureguiberry, 1991).

Crop coefficient (kc) for one year blueberry crops are of around 0,2 (Haman et al, 1997), also 0,97 values are also quoted in three year blueberry crop with drip irrigation systems (Riveros, 1996). It has been proved that different varieties of blueberries such as Berkeley and Blueray (Angelini and Bigaran, 1988)


MATERIALS AND METHODS

The experiment took place in an area inside a 33 has blueberry orchard, located in Calabacillas county, in the south of Concordia city, Entre Rios province, Argentina. Figure number 5, includes a map of Argentina, pointing blueberry areas with its corresponding cropped area.

Concordia is the main cropped area in Argentina (NEA, North East area), with 1600 has, followed by 1000 has, the North West area (NOA, northwest area), 950 has in North of Buenos Aires province. O’Neal variety was preferred because 80 % of the 1600 has of the area cropped with this variety.

The distance between rows is of 3 m, and 90 cm the distance between plants, determining 3703 plants per ha.

Soils are basically sandy, with at least 70 % of sand, ph with values around 5 and salinity of 0,3 dS x m⁻¹, with Cation Exchange Capacity of 8 meq x 100 g⁻¹.

There are local plantations of Pinus Elliotti, that are very useful to provide acid organic matter, as pine bark, pine dust, sawdust, etc, that contribute to improved better soils conditions for blueberry crops.

Irrigation water is from a semi confined aquifer, raised with and electric pump. Ph of the water is 6,5, electric conductivity is 0,14 dS x m⁻¹. Sodium absorption rate is 0,4.

Minisprinkler irrigation systems, are basically used us anti frost systems. Partial wetting system using 15 m³ x h⁻¹, or solid set systems using 33 m³ x h⁻¹, are developed in the area.

There are wells, producing up to 300 m³ x h⁻¹, for antifrost irrigation purposes, and other of around 150 m³ x h⁻¹ to provide irrigation systems. In the first case there diesel engines are mainly used, while electric pumps are used in the second case.

Irrigation method is a drip system, of two laterals per line of plants, trying to achieve a great wet area, due the minimum lateral movement of water in sandy soils. Distance between drippers were 30 cm, and the flow of 1,3 liters hour per emitter.
Evapotranspiration was measured in the field with a pan evaporating tank class A, and wind speed, and minimum and maximum temperature also measured daily.

Irrigation schedule was managed following data of gypsum blocks, being the irrigation threshold 15 cb.

Statistical design was randomized blocks. Each block has 5 plants, there were 5 repetitions, and treatments were the following.

T1: A drip irrigation system using 0.8 crop coefficient, without extra Calcium and potassium application.
T2: A drip irrigation system using 0.8 crop coefficient, and one foliar application of Calcium and Potassium.
T3: A drip irrigation system using 0.8 crop coefficient and two foliar application of Calcium and Potassium.
T4: A drip irrigation system using 1.2 crop coefficient, without extra Calcium and potassium application.
T5: A drip irrigation system using 1.2 crop coefficient, and one foliar application of Calcium and Potassium.
T6: A drip irrigation system using 1.2 crop coefficient and two foliar application of Calcium and Potassium.

RESULTS AND DISCUSSION

Statistical analysis of samples consisted in ANOVA. Mean values were compared through and Tukey test with p<0.05. Results showed significant differences between O’Neal blueberries yields, when 1.2 kc were compared to 0.8. Maximum yield was obtained from 1.2 kc, resulting in 2.801 kg x ha$^{-1}$ with 2.435 kg x ha$^{-1}$ in the 0.8 kc case. Results are shown in Table 1 and Figure 1.

Treatment number six which combined 1.2 crop coefficient and two foliar applications of Calcium and Potassium, than others and particularly significant compared to treatment number two, that combined 0.8 crop coefficient and only one dose of Calcium and Potassium. Table 2 and Figure 2, include details.

Further into analysis, we can see that treatment number six results in a higher production compare with treatment number two with p<0.01, when we analyze the number of fruits produced per tree, there were significant differences between the other treatments. Result can be seen in Table 3 and Figure 3.

Even though treatment two shows bigger weight than all the others, there are no significant differences even with p<0.20, as it can be seen in table 4 and Figure 4.

CONCLUSIONS

Concordia area is growing a very important region, to crop blueberries according with the deep, sandy and well drained soils, with low holding water capacity.

Local plantations of Pinus Elliotti, are very useful to provide acid organic matter, as pine bark, pine dust, sawdust, etc, that contribute to improved better soils conditions for blueberry crops.

Deep water of Concordia has no limitations to produce blueberries, according with the low salinity, appropriate pH, and very low SAR.

Even there are important rainfalls in the area, the shallow roots of the crop, combined with sandy soils, determine the requirement to add water to the soil with
irrigation systems. Drip irrigation systems, are the mainly elected systems for irrigation, while different type of sprinkler systems, are operating us anti frost systems.

There is a response to the increase of added water in O’Neal variety, in sandy soils in Concordia.

It’s also been probed that added Calcium and Potassium results in higher yield, when is combined with higher doses of water.

There is no significant response in weigh of fruits between treatments, It will interesting to test in different treatments the effect of calcium and potassium, measuring quantity and quality of fruits.

Irrigation management is a main subject to consider, due similar drip systems may produce different yields if we consider different crop coefficient.

Literature Cited


Tables

Table 1. Yield (kg x ha\(^{-1}\)) for different levels of kc

<table>
<thead>
<tr>
<th>Level kc</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,8</td>
<td>2434 a</td>
<td>877,98</td>
</tr>
<tr>
<td>1,2</td>
<td>2801 b</td>
<td>1102,75</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences (p<0.05)

Table 2. Yield (kg x ha\(^{-1}\)) for different levels of kc and dose of Ca and K

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>2577,3</td>
<td>979,1</td>
</tr>
<tr>
<td>T2</td>
<td>2186,3 a</td>
<td>812,1</td>
</tr>
<tr>
<td>T3</td>
<td>2513,6</td>
<td>810,2</td>
</tr>
<tr>
<td>T4</td>
<td>2747,3</td>
<td>956,5</td>
</tr>
<tr>
<td>T5</td>
<td>2548,4</td>
<td>967,6</td>
</tr>
<tr>
<td>T6</td>
<td>3160,1 b</td>
<td>1336,8</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences (p<0.05)

Table 3. Number of fruits for plant for different levels of kc and dose of fertilizers

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>462,7</td>
<td>192,6</td>
</tr>
<tr>
<td>T2</td>
<td>327,6 a</td>
<td>145,7</td>
</tr>
<tr>
<td>T3</td>
<td>421,5</td>
<td>158,1</td>
</tr>
<tr>
<td>T4</td>
<td>460,9</td>
<td>146,5</td>
</tr>
<tr>
<td>T5</td>
<td>434,1</td>
<td>188,4</td>
</tr>
<tr>
<td>T6</td>
<td>466,5 b</td>
<td>249,6</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences (p<0.10)
Table 4. Weight of fruit for plant for different levels of kc and dose of fertilizers

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>1,3643 a</td>
<td>0,1175</td>
</tr>
<tr>
<td>T2</td>
<td>1,7266 a</td>
<td>1,4400</td>
</tr>
<tr>
<td>T3</td>
<td>1,4284 a</td>
<td>0,1628</td>
</tr>
<tr>
<td>T4</td>
<td>1,4173 a</td>
<td>0,1410</td>
</tr>
<tr>
<td>T5</td>
<td>1,4258 a</td>
<td>0,2229</td>
</tr>
<tr>
<td>T6</td>
<td>1,4722 a</td>
<td>0,1587</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences (p<0,05)

Figures

Fig. 1. Yield (kg/ha) O’Neal of 22 months from transplant, with 2 levels of kc.
Figure 2. Yield (kg/ha) O’Neal of 22 months from transplant, for T1, T2, T3, T4, T5 and T6.

Figure 3. Fruits harvested by plant, O’Neal of 22 months from transplant, for T1, T2, T3, T4, T5 and T6.
Figure 4. Average weight of fruits (grams) O'Neal of 22 months from transplant, for T1, T2, T3, T4, T5 and T6.

Figures

Blueberries cropped per area

North West 1,000 ha
San Luis 100 ha
Patagonia 65 ha
North East 1,600 ha
BsAs North 950 ha
Bs.As. South 150 ha
Centro 250 ha

Fig. 5: Blueberry cropped per area